1999–2000 CATS ASSESSMENT
Open-Response Item Scoring Worksheet

Grade 4 – Science

The **academic expectation** addressed by the open-response item "Joe's Soil Experiment" is

2.1 Students understand scientific ways of thinking and working and use those methods to solve real-life problems.

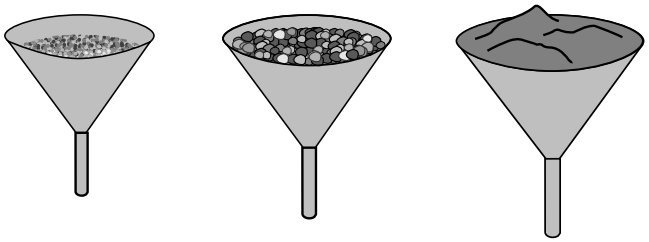
The **core content** addressed by this item includes:

Scientific Inquiry

- Students will review and ask questions about scientific investigations and explanations of other students.
- Students will design and conduct simple scientific investigations.
- Students will communicate (e.g., draw, graph, write) designs, procedures, observations, and results of scientific investigations.

Joe's Soil Experiment

Joe is doing an experiment to find out which type of soil soaks up the most water. He starts by getting three funnels and putting a different type of soil into each.



Sand Potting Soil Clay

Joe then pours water into each funnel until water begins to drip from the bottom. His experiment has some mistakes.

a. Describe TWO of the mistakes in the design of Joe's experiment.

b. Describe how Joe could correct the mistakes you described in **part a.**

SCORING GUIDE
Grade 4 Science

Score	Description
4	The response is complete and shows a strong understanding of how to design a simple controlled experiment. There is a clear, accurate description of two mistakes in the design of the experiment and a plausible way to correct both of the mistakes is described.
3	The response shows an understanding of how to design a simple controlled experiment. There is a description of two mistakes in the design of the experiment and a way to correct at least one is described. The response may lack detail or contain minor errors or misconceptions.
2	The response shows a limited understanding of how to design a simple controlled experiment. There is a description of a mistake(s) and/or of how to correct a mistake(s); however, the response may reveal misconceptions and/or contain errors or omissions.
1	The response is incomplete and shows a minimal understanding of how to design a simple controlled experiment. There may be an attempt to describe mistakes and/or correct the mistakes, but the response contains major errors, misconceptions, and omissions.
0	Response is totally incorrect or irrelevant.
Blank	No response.

Science Behind the Question:

In designing an experiment, it is important to control variables that could affect the outcomes. In this experiment, it would be important to have the same type and size of funnel, to use the same amount of each soil, and to pour the same amount of water into each funnel. A possible error is in providing a plug of material to prevent soil from washing from the funnel. So Joe needs a method of measuring how much water was absorbed and how much passed through, such as measuring how much water collects in a container under the funnel.

ANNOTATED STUDENT RESPONSE
Grade 4 Science

Sample 4-Point Response of Student Work

Student Response

Two mistakes Joe made are he didn't put the same amount of sand, potting soil or clay into the funnel. He could correct that mistake by measuring the soil.

Another mistake is he may not have used the same amount of water either. So he could correct that mistake by using a measuring cup to measure out the same amount of water in each funnel.

Those are two mistakes Joe made.

← Student accurately describes one mistake in the design of Joe's experiment (i.e., Joe did not put the same amount of soil in each funnel) and describes how the mistake could be corrected.

← Student accurately describes a second mistake in the design of Joe's experiment (i.e., Joe did not put the same amount of water in each funnel) and describes how the mistake could be corrected.

Overall, the student shows a strong understanding of how to design a simple controlled experiment. The student both accurately describes two mistakes in the design of the experiment and accurately describes how each mistake could be corrected.

ANNOTATED STUDENT RESPONSE
Grade 4 Science

Sample 4-Point Response of Student Work

Student Response

a. In Joe's experiment the two mistakes that Joe made were when he got the three funnels at different sizes, when they are supposed to be the same size, and he didn't put the same amount of soil in each funnel.

b. The way Joe could correct his first mistake is he could get to a store and buy the same size funnels either small, medium, or large. The way he could correct his second mistake is he could add more soil to the sand and potting soil, or he could take away some soil from the clay soil and the potting soil.

← Student accurately describes two mistakes in the design of Joe's experiment (i.e., Joe used different sizes of funnels and different amounts of soil).

← Student accurately describes how each of the mistakes could be corrected (i.e., Joe could buy funnels of the same size and he could even the amount of soil in each funnel).

Overall, the student shows a strong understanding of how to design a simple controlled experiment. The student both accurately describes two mistakes in the design of the experiment and accurately describes how each mistake could be corrected.

ANNOTATED STUDENT RESPONSE
Grade 4 Science

Sample 3-Point Response of Student Work

Student generally describes two mistakes in the design of Joe's experiment (i.e., Joe did not put cups under the funnels and he "put two much clay"). Response lacks detail (e.g., the purpose of the cups) and the second mistake only addresses part of the soil amount problem (i.e., none of the three funnels contained the same amount of soil).

→

Student Response

I'm going to discribe two of the mistakes in the design of Joe's experiment. Joe for got the cups to put under the Funnles. And put two much clay.

He could put the cups under the funnels and He could take some clay out.

I just told you how Joe made mistakes on.

←

Student generally describes how each of the mistakes could be corrected (i.e., Joe "could put cups under the funnels" and he "could take some clay out"). Again, the second correction only addresses part of the soil amount problem.

Overall, the student shows a general understanding of how to design a simple controlled experiment. The student generally describes two mistakes in the design of the experiment and generally describes how each of the mistakes could be corrected. One of the described mistakes and its correction is somewhat incomplete.

ANNOTATED STUDENT RESPONSE
Grade 4 Science

Sample 2-Point Response of Student Work

Student Response

a. I will Describe 2 of the mistakes design of Joe's experiment.

There Diffent sizes funls.

Clay is not a potting soil.

b. I will Describe how Joe could correct the mistakes.

If they got the sam size funls it would be better.

if they got dirt it would be better.

← Student accurately describes one mistake in the design of Joe's experiment (i.e., Joe used different sizes of funnels). Student attempts to describe a second mistake (i.e., "clay is not a potting soil"), but the description does not reflect a mistake in the design of the experiment.

← Student accurately describes how Joe could correct the funnel mistake (i.e., Joe could use funnels of the same size) and attempts to describe how to correct the soil mistake.

Overall, the student shows some understanding of how to design a simple controlled experiment. The student accurately describes one mistake in the design of the experiment and accurately describes how to correct that mistake.

ANNOTATED STUDENT RESPONSE
Grade 4 Science

Sample 1-Point Response of Student Work

Student Response

A) (1) The clay in one funnel will soak up the water but start to leak out the bottem, the clay will probably get on him and will not come out of his clothes.

(2) The sand will not soak up water it will run out of the bottem. Joe needed to get funnels without wholes in the bottom.

B) (1) Joe could just use the 2 other soils.

(2) Joe could buy some funnels that didn't have any holes in them or get a bucket for each one.

← Student attempts to describe two mistakes Joe made in the design of his experiment, but neither mistake is correct.

← Student accurately states that Joe could put a bucket under each funnel.

Overall, the student shows a minimal understanding of how to design a simple controlled experiment by accurately stating that a bucket could be put under each funnel used in the experiment.

INSTRUCTIONAL STRATEGIES
Grade 4 Science

The open-response item **"Joe's Soil Experiment"** was designed to address students' (1) understanding of scientific ways of thinking and working, and the use of those methods to solve real-life problems, and (2) ability to review and analyze scientific investigations. The instructional strategies below present ideas for helping students explore and master these concepts and skills.

Discuss the following concepts and skills with students:

- review and analysis of scientific investigations of other students
- design of scientific investigations
- experimental design and inquiry skills
- communication of procedures and observations of scientific investigations
- Earth materials, including solid rocks and soil, water, and gases of the atmosphere
- soil properties, including color, texture, and the capacity to retain water

Provide opportunities for students to work individually, in pairs, in small groups, and/or as a class to complete (with teacher guidance and support) any or all of the following activities:

- Explore the composition of different types of sands and soils. Use simple tools (e.g., hand lens) to compare properties (e.g., color, texture) of sand, clay, gravel, potting soil, and soil from the property around the school building. Record observations.
- Explore the porosity of different soil types. Determine which soil sample holds the most water. Compare the porosity of sand; clay; gravel; a mixture of sand, clay, and gravel; potting soil; and soil from the property around the school building. Explain why some types of soils hold more water than other types.
- Develop questions about objects or organisms in students' environment that might be answered through scientific investigation. Decide if the questions are appropriate (can be answered with simple classroom materials in a reasonable amount of time).
- Design and conduct simple investigations to answer students' questions. Discuss the idea of a fair test. Give examples and non-examples. Make sure any tests conducted by students are fair. Discuss the concept of repeated trials and why multiple trials should be conducted.
- Discuss the idea of a variable (i.e., something a researcher can change that affects the outcome of the investigation). Discuss ways to change variables and which variables can be changed. Discuss the importance of changing one variable at a time, while keeping the others the same. Investigate the meaning of an experimental control. Identify the control in student experiments.

- Discuss which properties of objects or organisms should be measured and identify the appropriate tools. Develop charts to organize data.
- Introduce and develop graphing skills. Discuss the appropriate use of different graphic representations.
- Discuss the importance of good communication and sharing of results. Brainstorm ways to share results. Explore why it is important for scientists to review and critique each other's work.
- Read stories about scientific discoveries and discuss the procedures and results of the investigations.
- Interview scientists in the community and ask about their work. Invite scientists to school and ask about the procedures they use in their work.